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In re the Application of
Hiroyuki Oda

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For: PAPERMAKING PRESS FELT AND PRESS APPARATUS FOR A PAPERMAKING MACHINE

Art Unit: 1731

Examiner: Eric J. Hug

VERIFICATION OF TRANSLATION

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Yohei Kinoshita, having been warned that willful false statements and the like are punishable by fine or imprisonment or both, under section 1001 of Title 18 of the United States Code, and may jeopardize the validity of the above-captioned application and any patent issuing thereon, declare:

(1) I am a patent attorney authorized to practice law in Japan and am engaged in the practice of law at Teclaw Patent & Law Office, Nishi-Shimbashi 3-chome, Minato-ku, Tokyo 105-0003.

(2) I am fluent in the Japanese and English Languages.

(3) I certify that the attached translation is an accurate English translation of Japanese patent application 310008/2002, filed October 24, 2002, including the drawings.

(4) All of the statements made herein of my own knowledge are true and all statements made herein on information and belief are believed to be true.

November 1, 2005
Date

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[Name of Document] Patent Application

[Reference No.] 02P022

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[Name of Document] Specification 1

[Name of Document] Drawings 1

[Name of Document] Abstract 1

[Necessity of Proof] Yes

[Document Name] Specification

[Title of the Invention] Papermaking press felt and press apparatus for a papermaking machine

[What is claimed is]

[Claim 1] A papermaking press felt comprising a base body and a batt layer which has a wet paper web side layer and a press side layer,

characterized in that a hydrophilic nonwoven fabric is provided in the wet paper web side layer of said batt layer.

[Claim 2] A papermaking press felt as claimed in claim 1, wherein said batt layer comprises a staple fiber and fineness of said staple fiber which is located in a wet paper web side relative to said hydrophilic nonwoven fabric is 9 dtex or less.

[Claim 3] A papermaking press felt as claimed in claim 1 or 2, wherein a weight ratio of the batt layer which is located in a wet paper web side relative to said hydrophilic nonwoven fabric to the hydrophilic nonwoven fabric is from 8:1 to 3:1.

[Claim 4] A papermaking press felt as claimed in any one of claims 1-3, wherein as for a hydrophilic level of said hydrophilic nonwoven fabric, the water contact angle is 30 degrees or less in a condition where water content of the nonwoven fabric is 30-50%.

[Claim 5] A press apparatus for a papermaking machine comprising a first press apparatus and a second press apparatus provided in the downstream thereof, pinching a wet paper web by two sheets of felts and removing water from said wet paper web,

characterized in that a papermaking press felt as claimed in any one of claims 1-4 is used in said first press apparatus or said second press apparatus.

[Claim 6] A press apparatus for a papermaking machine

comprising a first press apparatus and a second press apparatus provided in the downstream thereof, pinching a wet paper web by two sheets of felts and removing water from said wet paper web

characterized in that a papermaking press felt as claimed in any one of claims 1-4 is used in said first press apparatus and said second press apparatus.

[Claim 7] A press apparatus for a papermaking machine comprising only a first press apparatus pinching a wet paper web by two sheets of felts and removing water from said wet paper web

characterized in that a papermaking press felt as claimed in any one of claims 1-4 is used in said first press apparatus.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention belongs]

The present invention relates to a felt which is used in a press part of a papermaking machine, especially a papermaking press felt which is capable of improving a water removing capability (hereinafter referred to as a "press felt") and a press part of a papermaking machine utilizing the press felt.

[0002]

[Prior Art]

Conventionally, a press apparatus which is shown in Figure 1 is used for squeezing water from a wet paper web in a papermaking process.

The role of a press apparatus will be briefly explained referring to Figure 1. A wet paper web W with density of 15-18 % which is formed in a wire part is sucked onto a suction pickup roll 2 and attached to a pickup felt 3 and transferred. Water is squeezed from the wet paper web through the felt 3 and a bottom felt 4 in a first press

1P which is referred to as a double felt press, comprising the felts 3, 4, a suction roll 5 and a grooved roll 6a.

[0003]

Furthermore, the wet paper web is held on the surface of the pickup felt 3 and sucked by vacuum of the suction roll 5. Water is squeezed from the wet paper web in a second press 2P which is referred to as a single felt press, comprising a center roll 6 having a smooth surface and a grooved roll 6b.

A rewetting phenomenon occurs in this process where the wet paper web is transferred from the first nip to the second nip.

[0004]

Next, after the pickup felt 3 transfers the wet paper web W to the center roll 6 having a dense surface, water is squeezed from the wet paper web in a third press 3P comprising the roll 6 and a third grooved roll 6c, and in a fourth press 4P comprising a roll 7 and a grooved roll 6d. Thereafter, the wet paper web is transferred to a dryer part comprising a dryer roll 8 etc. in the next process.

[0005]

In this way, this press apparatus comprises the first to the fourth press nips. The press nip is shown in detail in Figure 2.

This press nip comprises a pair of press rolls P, P and a pair of press felts 11, 11 pinching a wet paper web. The press felts 11, 11 and the wet paper web W is pressurized in a press part of the press rolls P, P and thus, water is squeezed from the wet paper web W.

In this connection, while Figure 2 shows what is called, a roll press wherein a nip comprises two rolls, a shoe press nip comprising a roll and a shoe press module has the same effects and press felts 11, 11 absorbs water which is squeezed from a wet paper web W.

[0006]

Here, the structure of a press felt 11 which is generally used will be explained referring to Figure 3. In this connection, Figure 3 is a cross-sectional view taken on a cross machine direction.

A press felt 11 of the figure comprises a base body 20 and a batt layer 30 and is endless.

In addition to above, the batt layer 30 comprises a wet paper web side layer 31 and a press side layer 32. The batt layer 30 is formed by punching a batt fiber to the base body 20 with a needle and therefore, the batt fiber is also provided inside the base body 20.

[0007]

Here, the moving state of water from the wet paper web in the press part of Figure 2 will be explained referring to Figure 4. In this connection, only one press felt 11 is shown in Figure 4 for simplifying an explanation.

When a pair of press rolls P, P rotate in the direction of an arrow of the figure, press felts 11, 11 and a wet paper web W which are pinched by the press rolls P, P pass through a press part.

As mentioned above, the press felts 11, 11 and the wet paper web W are pressurized in the press part and water which is in the wet paper web W is squeezed and absorbed in the press felts 11, 11.

[0008]

However, when the wet paper web and the press felts are transferred from the center to the delivery side of the press part, pressure applied to the wet paper web W and the press felts 11, 11 is rapidly released and the press felts 11, 11 and the wet paper web W expand their volume rapidly in this part.

As a result, a negative pressure is created in the press felts 11, 11 and moreover a capillary phenomenon also occurs since the wet paper web comprises a thin fiber and these cause the water absorbed

in the press felts 11, 11 to move to the wet paper web W again.

It is called a rewetting phenomenon and is generally known by those skilled in the art as a problem of a conventional press apparatus.

In this connection, while Figure 4 shows a case of a roll press nip, the same phenomenon occurs in the case of a shoe press nip and this is a great cause of decreasing water removing capability of a press apparatus.

[0009]

Among conventional press felts, there is one wherein a barrier layer 41 comprising a super-fine fiber or a hydrophilic material is formed in a press side layer 32 of a batt layer 30 as shown in Figure 5 so that a rewetting phenomenon may be prevented (by way of example, refer to Patent Document 1).

In addition, there is a structure wherein a hydrophobic spunbond 42 is provided in a wet paper web side layer 31 of a batt layer 30 as shown in Figure 6 (by way of example, refer to Patent Document 2).

[0010]

[Patent Document 1]

Unexamined Japanese Patent Publication 8888/1991 (Page 3)

[Patent Document 2]

U.S. Patent No. 5372876 (Page 4, Figure 2)

[0011]

[Problems to be solved by the Invention]

However, it was found out from results of experiments that the structures shown in Figures 5, 6 were not sufficient for preventing a rewetting phenomenon.

In the case of a press felt 12 of Figure 5, this is seemingly due to the fact that while water is held in the barrier layer 41, water in a wet paper web side layer 31 wherein the barrier layer 41 is not

provided moves to a wet paper web after the press felt is released from a press part.

[0012]

In addition, in the case of a press felt 13 of Figure 6, the hydrophobic spunbond 42 prevents water which is located in a roll side relative to the spunbond 42 from moving to a wet paper web. However, the press felt 13 of Figure 6 does not function as a preventive measure against a rewetting phenomenon effectively. This is seemingly due to the fact that since the spunbond 42 is hydrophobic, water held inside the spunbond 42 and water which is located in a wet paper web side of the batt layer relative to the spunbond 42 move to the wet paper web with ease.

[0013]

In view of the above problems, it is an object of the present invention to provide a papermaking press felt and a press apparatus which may prevent a rewetting phenomenon.

[0014]

[Means to solve the Problems]

The present invention solved the above-mentioned problems by providing a papermaking press felt comprising a base body and a batt layer which has a wet paper web side layer and a press side layer, characterized in that a hydrophilic nonwoven fabric is provided in the wet paper web side layer of said batt layer.

[0015]

[Function]

According to the present invention, a papermaking press felt having excellent effects of preventing a rewetting phenomenon may be provided by a relatively simple structure of having a hydrophilic nonwoven fabric in a wet paper web side layer of a batt layer. In

addition, a press apparatus having an excellent water removing capability may be provided by mounting this press felt on the press apparatus of a papermaking machine.

[0016]

[Embodiments]

An embodiment of a press felt according to the present invention will be explained referring to Figures 7, 8. In this connection, Figures 7, 8 are cross-sectional views taken on a cross machine direction.

A press felt 10 of the figure comprises a base body 20, a batt layer 30 and a hydrophilic nonwoven fabric 40, which are intertwiningly integrated by needle punching.

[0017]

The base body 20 is provided for imparting strength to the press felt. A woven fabric, a structure wherein yarns are not woven but stacked, or film etc. which are suggested by those skilled in the art may be adequately used as its material.

The batt layer 30 comprises a staple fiber 50 and has a wet paper web side layer 31 and a press side layer 32. In this connection, it is needless to say that the staple fiber 50 is also provided in the base body 20.

[0018]

A fiber with fineness of 6 dtex or more is used as the staple fiber 50 forming the batt layer 30. Generally, a fiber with fineness of about 17 dtex is used in many cases.

In this connection, a natural fiber such as wool and a synthetic fiber such as nylon 6 and nylons 66 which are superior in wear resistance, fatigue resistance, extension characteristics and stain resistance are used as a material for the base body 20 and the batt

layers 30.

[0019]

The hydrophilic nonwoven fabric 40 is provided in the wet paper web side layer 31 of the batt layer 30. Therefore, the wet paper web side layer 31 has a first wet paper web side layer 31a which is located in a wet paper web side relative to the hydrophilic nonwoven fabric 40 and a second wet paper web side layer 31b which is located in a roll side relative to the hydrophilic nonwoven fabric 40.

The hydrophilic nonwoven fabric 40 comprises a fiber which is thinner and of higher density as compared with the batt layer 30. Concretely, it is formed by laminating a fiber which is made by melting and spinning resin. For example, a spunbonded nonwoven fabric formed by laminating a continuous filament, or a nonwoven fabric formed by extending molten polymer with hot blast and making it a fine fiber and forming a sheet therefrom etc. may be used appropriately. In this connection, it is suitable that its fineness is 4 dtex or less.

[0020]

In this connection, nylon may be used as its material.

In addition, as for a hydrophilic level, when the water contact angle is 30 degrees or less in a condition where water content of a nonwoven fabric 40 is adjusted to 30-50%, excellent results may be obtained. In addition to above, percentage of the above water content of the nonwoven fabric 40 may be calculated by the following equation:

(weight of water/the whole weight) x 100.

[0021]

In this connection, as for "hydrophilic properties of a nonwoven fabric" of the present invention, it is sufficient that the nonwoven fabric has "hydrophilic properties" when a papermaking press

felt is in a normal use condition.

When a nylon spunbond which is generally sold is purchased and used as a "nonwoven fabric" of the present invention, there is a case where it is hydrophobic at the time of purchase.

This is due to the fact that hydrophobic spinning oil is used in a normal manufacturing method of a spunbond for improving opening properties and fiber cohesion of a spunbond. However, this hydrophobic oil escapes from the spunbond at a very early stage of use of a paper-making felt.

In other words, even when a nonwoven fabric is hydrophobic at the time of purchase of material, the object of the present invention may be achieved only if the nonwoven fabric is hydrophilic at the time of use.

[0022]

Next, functions of a press felt 10 shown in Figure 7 will be explained.

First, water from a wet paper web moves to a press felt 10 under pressure of press rolls.

As explained above, when the press felt travels further and is released from the pressure, said rewetting phenomenon occurs. However, in the case of a press felt 10 according to the present invention, a hydrophilic nonwoven fabric 40 has a higher density and lower water permeability than a batt fiber. Therefore, especially, water in a batt layer which is located in a roll side relative to the hydrophilic nonwoven fabric 40, i.e. a second wet paper web side layer 31b of a press side layer 32 has a difficulty of passing through the hydrophilic nonwoven fabric 40 and returning to the wet paper web.

[0023]

Furthermore, since fineness of the hydrophilic nonwoven

fabric 40 is lower than that of the batt layer 30, water held in a first wet paper web side layer 31a moves to the hydrophilic nonwoven fabric 40 without difficulty due to a capillary phenomenon.

[0024]

Furthermore, a hydrophilic function of the hydrophilic nonwoven fabric 40 remarkably improves a function of moving water to the nonwoven fabric 40, and a function of holding the moved water in the nonwoven fabric. This is called "hydration force".

Water in the first wet paper web side layer 31a which is the nearest to a wet paper web is held in the first wet paper web side layer 31a by a function of hydration force or is prevented from moving to the wet paper web by effects of the hydrophilic nonwoven fabric 40.

Therefore, a press felt according to the present invention may prevent a rewetting phenomenon more effectively than a conventional one.

[0025]

In this connection, water held in the first wet paper web side layer 31a which is located in a wet paper web side relative to the hydrophilic nonwoven fabric 40 is less likely to cause a rewetting phenomenon due to the above hydration force of the hydrophilic nonwoven fabric 40 as compared with that of the conventional structure. However, part of water in the first wet paper web side layer 31a moves to the wet paper web.

[0026]

Hydration force of the first wet paper web side layer 31a may be increased by using a fiber which is thinner than a conventional one as a staple fiber 50 of the first wet paper web side layer 31a as shown in Figure 8 so that the amount of water moving from the first wet paper web side layer 31a to the wet paper web may be further reduced.

In this case, since the staple fiber 50 of the first wet paper web side layer 31a which is in direct contact with the wet paper web is thinner than a conventional fiber, a difference of fineness between the staple fiber 50 of the first wet paper web side layer 31a and a fiber of the wet paper web becomes relatively small. Therefore, the amount of water moving from the first wet paper web side layer 31a to the wet paper web due to a capillary phenomenon becomes relatively small as compared with the past.

[0027]

In this connection, it was found out from results of tests that excellent effects might be obtained when fineness of a staple fiber 50 of a first wet paper web side layer 31a was 9 dtex or less.

In addition to above, while tests were conducted by changing fineness of a staple fiber 50 of a first wet paper web side layer 31a etc., it was found out that a weight ratio of the first wet paper web side layer 31a to a hydrophilic nonwoven fabric layer had a close relation with prevention of a rewetting phenomenon.

It was found out that a weight ratio (basis weight ratio) of a first wet paper web side layer 31a to a hydrophilic nonwoven fabric layer 40 was preferably from 8:1 to 3:1.

It is suitable that basis weight of a first wet paper web side layer 31a is 100-200 g/m^2 and basis weight of a hydrophilic non-woven fabric 40 is in the range of about 16-50 g/m^2 .

[0028]

[Examples]

The following tests were conducted to determine the effects of a papermaking press felt according to the present invention.

In this connection, a basic structure of all felts was as follows so that conditions were common to both examples and comparative

examples:

Base body (plain weave of twine of nylon monofilament): Basis weight 300 g/m^2

Batt layer (staple fiber of nylon 6): Total basis weight 550 g/m^2

Density of needle punching: 700 times/cm^2

[0029]

Except Comparative Examples 1, 2, a hydrophilic nonwoven fabric was provided in a wet paper web side layer of a batt layer and the batt layer 30 has a first wet paper web side layer and a second wet paper web side layer. In case of examples and comparative examples except Comparative Examples 1, 2, fineness of the second wet paper web side layer and a press side layer 32 was 17 dtex.

As shown in Figure 11, examples and comparative examples were obtained by changing a material, fineness and basis weight of a batt layer and in the case of Examples 1-7 and Comparative Examples 3, 4, changing structure and basis weight of a nonwoven fabric layer, and water contact angle on the nonwoven fabric layer.

[0030]

Tests were conducted by using the above papermaking press felts of the examples and the comparative examples and apparatuses shown in Figures 9, 10.

First, as for the apparatuses shown in Figures 9, 10, P stands for a press roll and 110 stands for a top side felt and 10 stands for a bottom side felt and SC stands for a suction tube and SN stands for a shower nozzle.

In this connection, the above examples and the comparative examples were used as a bottom side felt 10 in any apparatus. In addition to above, the same press felt as Comparative Example 1 was used as a top side felt.

Moreover, both apparatuses shown in Figures 9, 10 have a felt running speed of 500 m/min and a press pressure of 100 kg/cm^2 .

[0031]

The apparatus shown in Figure 9 has a structure wherein a wet paper web released from the nip pressure is placed on a bottom side felt 10 and transferred. Therefore, data of water content of the wet paper web in which a rewetting phenomenon occurs may be obtained by measuring the wettability of the wet paper web at the location (press exit 1) where after released from the nip pressure, the wet paper web is placed on the bottom side felt and transferred.

[0032]

On the other hand, in the case of the apparatus shown in Figure 10, an area of a bottom side felt 10 which is in contact with a press roll is comparatively large and the period of time during which a wet paper web is in contact with the felts 10, 110 after released from the nip pressure is very short. Therefore, data of water content of a wet paper web in the case where a rewetting phenomenon does not fully occur may be obtained by measuring the wettability of the wet paper web (at a press exit 2) right after the wet paper web is released from the nip pressure.

[0033]

Here, the evaluation of a rewetting phenomenon was conducted by calculating the difference between the data of water content obtained by the apparatus of Figure 9 and the data obtained by the apparatus shown in Figure 10. In this connection, when the difference between them was below 0.5%, it was judged that a rewetting phenomenon did not occur (evaluation:"○ "). On the other hand, when the difference between them was 0.5% or more and below 10%, it was judged that a re-wetting phenomenon occurred a little (evaluation:"△ ") and when the

difference between them was above 1.0%, it was judged that a rewetting phenomenon occurred (evaluation:"× ").

[0034]

The summary of these results is shown in Figure 11.

As shown in Figure 11, it was found out that a papermaking press felt according to the present invention was capable of suppressing a rewetting phenomenon effectively and has excellent effects.

Especially, effects obtained when a nonwoven fabric was hydrophilic were determined by comparing Example 1 and Comparative Example 3.

In addition, it was found out from Examples 1-5 that a basis weight ratio of a first wet paper web side layer of a batt layer to a nonwoven fabric layer was preferably from 8:1 to 3:1.

Furthermore, it was found out from Examples 1, 6, 7 that fineness of a first wet paper web side layer of a batt layer was preferably 9 dtex or less.

[0035]

Next, tests were conducted by changing the period of time during which a felt was in contact with a wet paper web after passing through a press nip and the effects of this papermaking press felt were determined.

A schematic block diagram of a test apparatus is shown in Figure 12. Tests were conducted by using two kinds of felts, a conventional felt (Comparative Example 1) and a felt according to the present invention (Example 1) as a bottom felt.

[0036]

Tests were conducted by using an apparatus shown in Figure 12 and passing a wet paper web which was not pressed through a press nip. The relation between a felt contact time and the amount of re-

wetting was examined by changing the period of time during which a wet paper web was pinched by top and bottom felts after passing through a press nip. The results are shown in Figure 13.

As shown in Figure 13, it was found out that a felt according to the present invention had excellent effects of preventing a rewetting phenomenon since the amount of rewetting did not increase but, remained constant while in the case of a conventional felt, the amount of re-wetting increased along with the increase of a felt contact time.

[0037]

A press apparatus for a papermaking machine on which a felt according to the present invention is mounted is shown in Figure 14. This press apparatus for a papermaking machine 100 comprises a first press apparatus 103 and a second press apparatus 203 provided in the downstream thereof, pinching a wet paper web W by two sheets of felts and squeezing water from the wet paper web W. While Figure 14 shows a case where a felt 10 according to the present invention is used for a bottom felt of the second press apparatus 203, the present invention is not limited to this case. In other words, a press felt 10 may be used in either the first press apparatus 103 or the second press apparatus 203, or may be used in both the first press apparatus 103 and the second press apparatus 203.

[0038]

A wet paper web W is pinched between felts or held on a bottom felt and transferred so that a high-speed transfer performance of the wet paper web may be obtained. Therefore, a wet paper web may be stably transferred at high speed (without suspension of paper supply) throughout the whole section by holding it between or on the felts according to the present invention.

Especially, it is desirable that a felt according to the

present invention is used for a bottom felt of the second press apparatus 203 since a final water content of the wet paper web is controlled by the second press apparatus 203.

[0039]

In this type of press, a wet paper web is held between felts or on a felt after passing through a nip. Therefore, a rewetting phenomenon occurs in this section and water returns to the felt again and this decreases a water removing capability. However, water removing capability may be greatly improved by replacing a conventional felt with a felt according to the present invention.

In this connection, while Figure 14 shows a shoe press apparatus of a papermaking machine comprising two shoe presses which are provided in series, a felt according to the present invention may prevent a rewetting phenomenon effectively even when one shoe press apparatus is replaced with a roll press apparatus or when a shoe press apparatus comprises one shoe press.

[0040]

[Advantages of the Invention]

As explained above, according to the present invention, a papermaking press felt having excellent effects of preventing a rewetting phenomenon may be provided by a relatively simple structure of having a hydrophilic nonwoven fabric in a wet paper web side layer of a batt layer. In addition, the effects of being able to provide a press apparatus having an excellent water removing capability may be obtained by mounting this press felt on a press apparatus of a papermaking machine.

[Brief Description of Drawings]

[Figure 1] A schematic explanatory view of a press apparatus of a papermaking machine;

[Figure 2] A schematic explanatory view of a press nip;

[Figure 3] A cross-sectional view of a conventional press felt;

[Figure 4] An explanatory view of the moving state of water from a wet paper web in a press part;

[Figure 5] A cross-sectional view of another conventional press felt;

[Figure 6] A cross-sectional view of other conventional press felt;

[Figure 7] A cross-sectional view of an embodiment of a press felt according to the present invention;

[Figure 8] A cross-sectional view of another embodiment of a press felt according to the present invention;

[Figure 9] A schematic view of an apparatus for determining effects of a press felt according to the present invention;

[Figure 10] A schematic view of another apparatus for determining effects of a press felt according to the present invention;

[Figure 11] A chart showing results of tests conducted by apparatuses of Figures 9, 10;

[Figure 12] An explanatory view of a test apparatus for measuring the amount of rewetting;

[Figure 13] A chart showing results of tests conducted by an apparatus of Figure 12; and

[Figure 14] A schematic view of a press apparatus of a papermaking machine on which a felt according to the present invention is mounted.

[Explanation of Reference Letters or Numerals]

10: Papermaking press felt

20: Base body

30: Batt layer

31: Wet paper web side layer

32: Press side layer

40: Hydrophilic nonwoven fabric

100: Press apparatus for a papermaking machine

103: First press apparatus

203: Second press apparatus

F: Felt

Document Name] Abstract

[Abstract]

[Problems]

To provide a papermaking press felt and a press apparatus which may prevent a rewetting phenomenon and improve a water removing capability.

[Solution Means]

A press felt 10 comprises a base body 20, a batt layer 30 and a hydrophilic nonwoven fabric 40, which are intertwiningly integrated by needle punching. The batt layer 30 comprises a staple fiber 50 and has a wet paper web side layer 31 and a press side layer 32. The hydrophilic nonwoven fabric 40 is provided in the wet paper web side layer 31.

A hydrophilic function of the hydrophilic nonwoven fabric 40 improves a function of moving water to the nonwoven fabric 40, and a function of holding the moved water in the nonwoven fabric. Therefore, a rewetting phenomenon may be prevented more effectively than before.

[Selected Drawing] Figure 7

FIG. 1

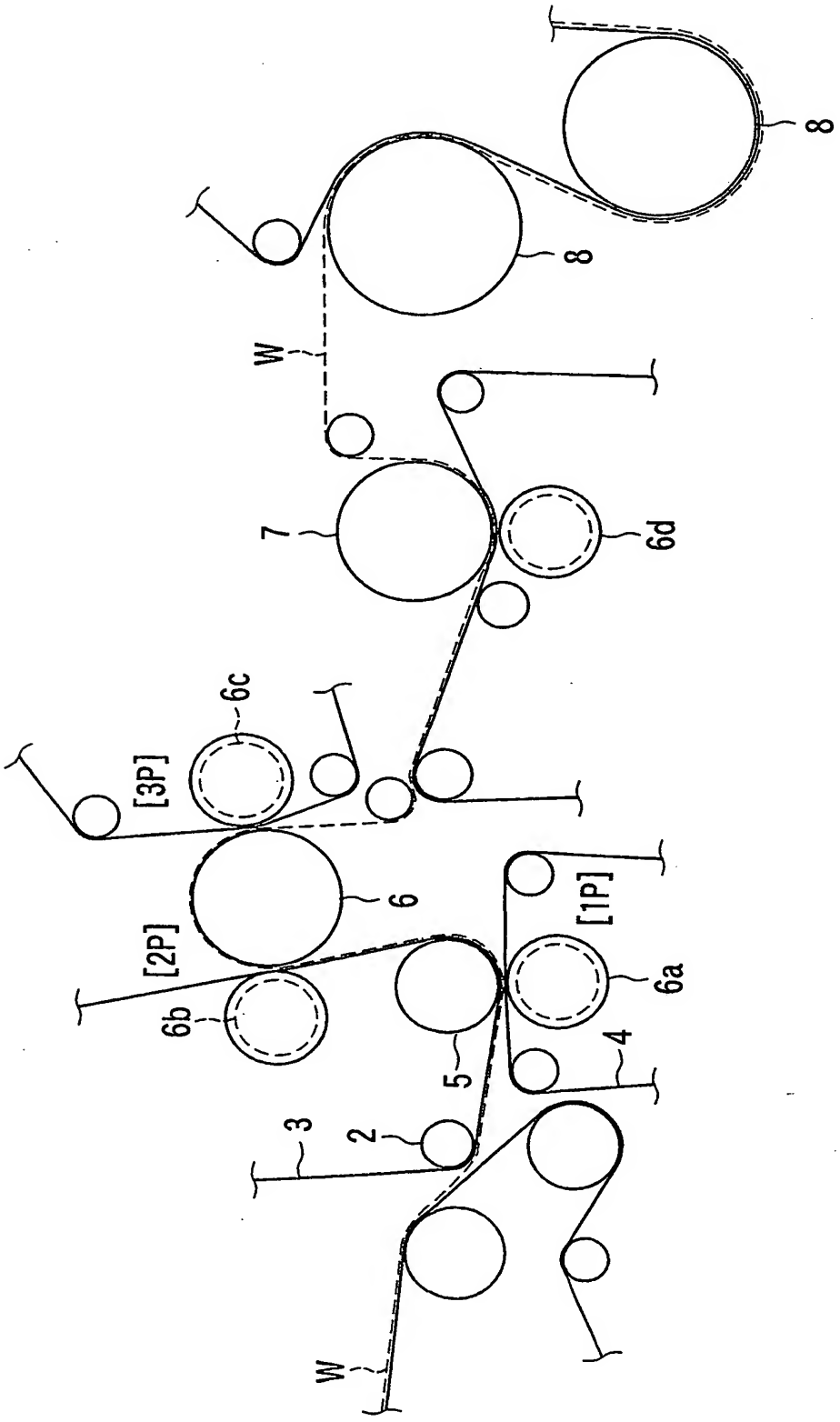


FIG. 2

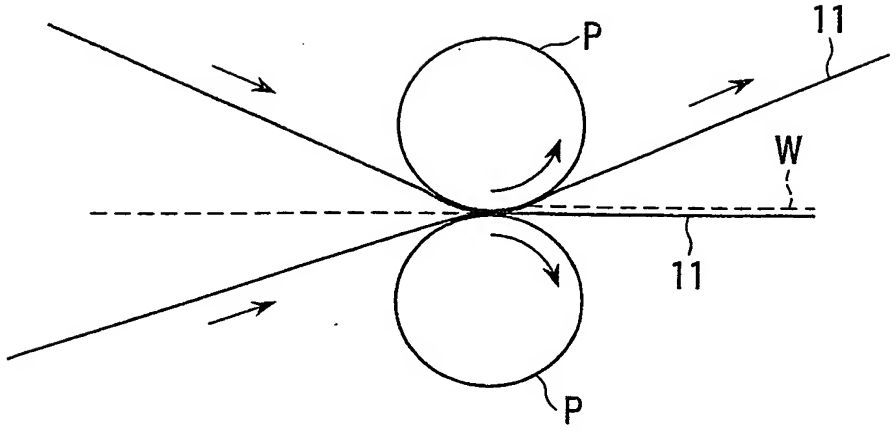


FIG. 3

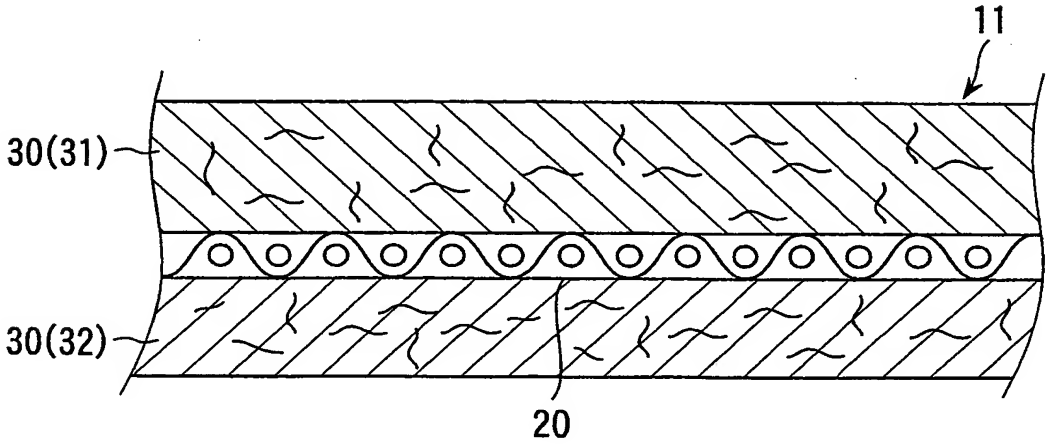


FIG. 4

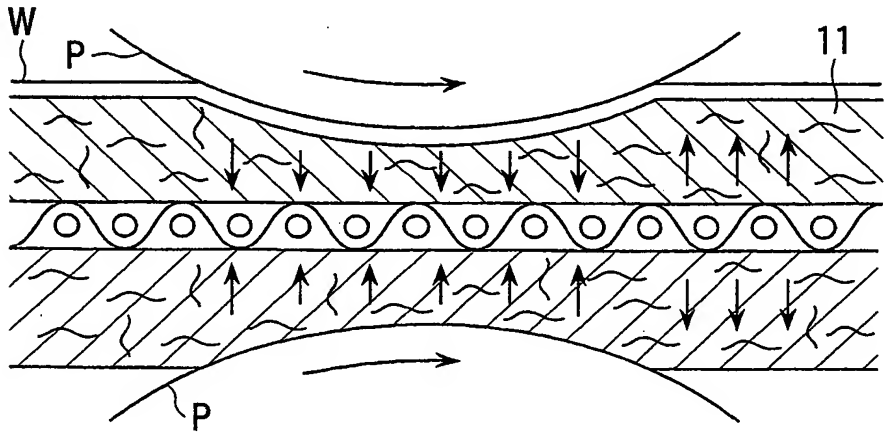


FIG. 5

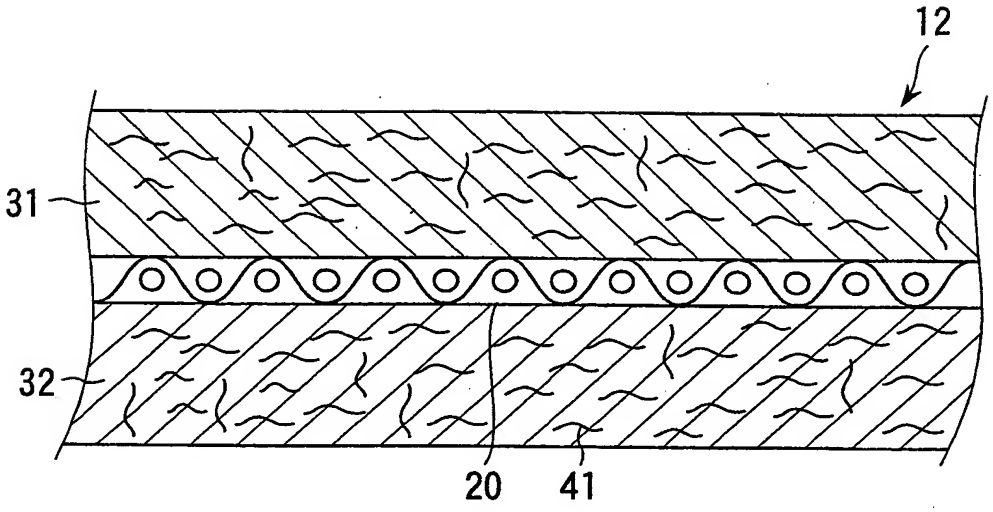


FIG. 6

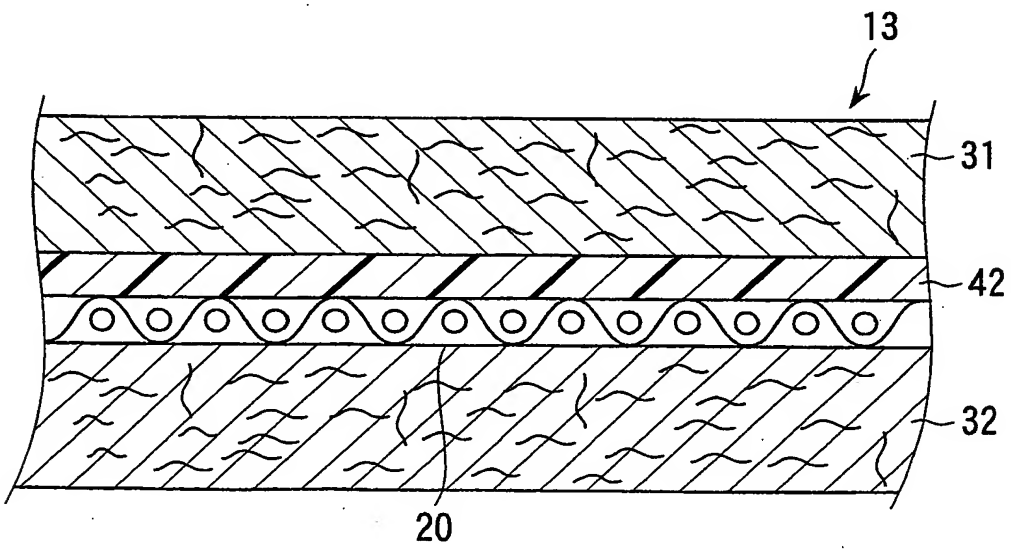


FIG. 7

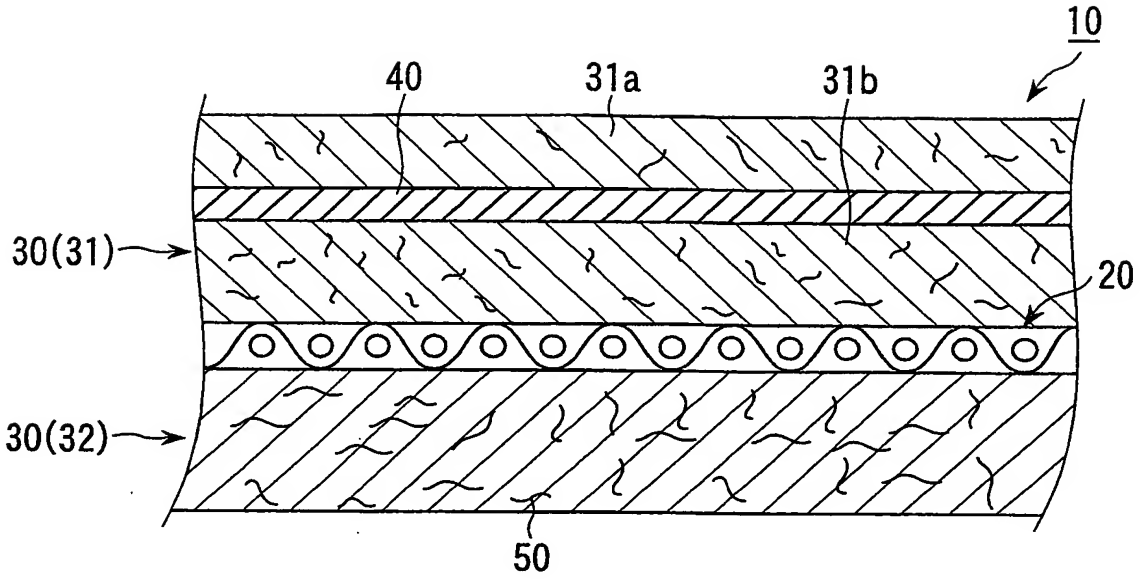


FIG. 8

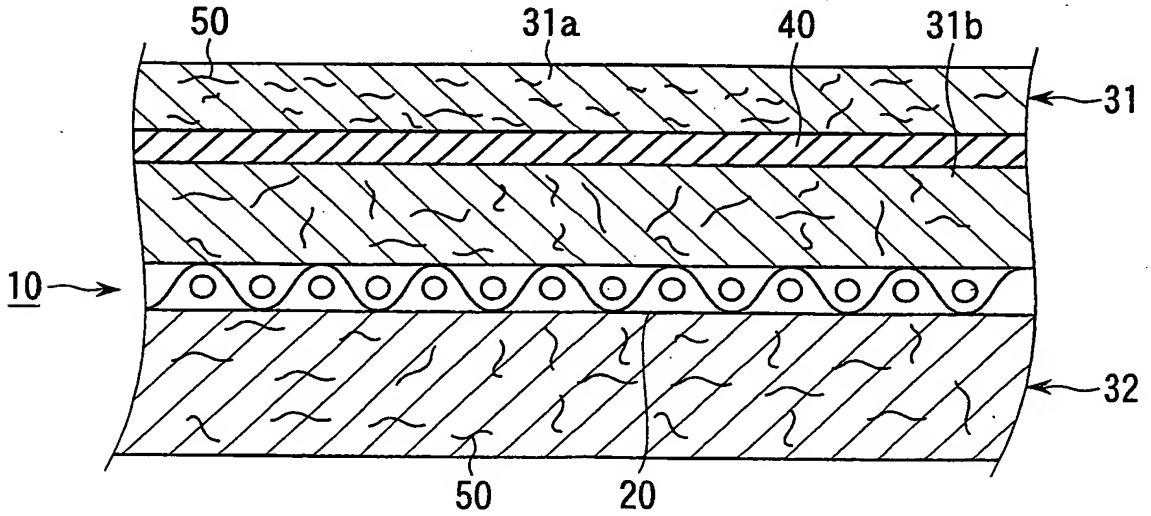


FIG. 9

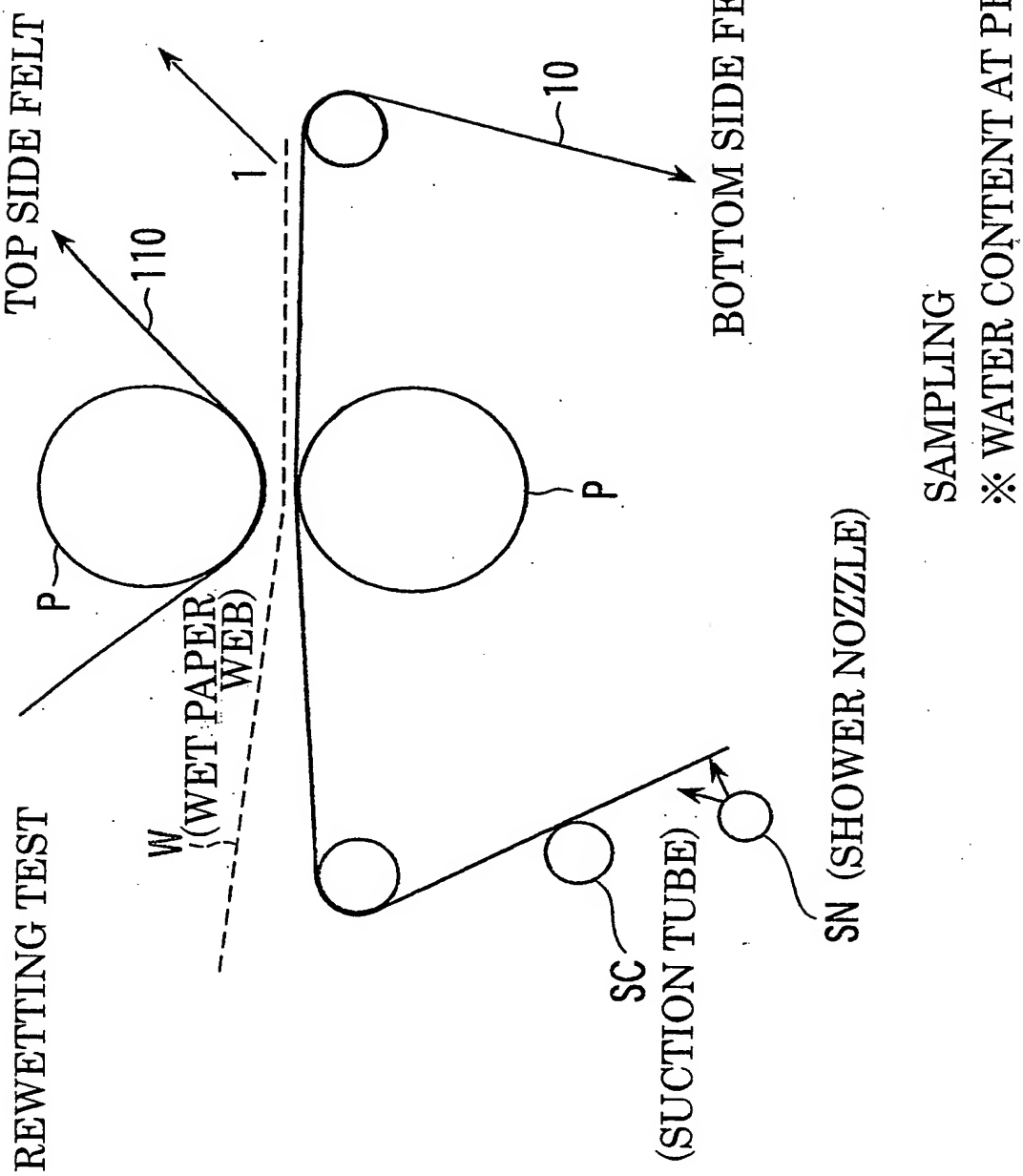
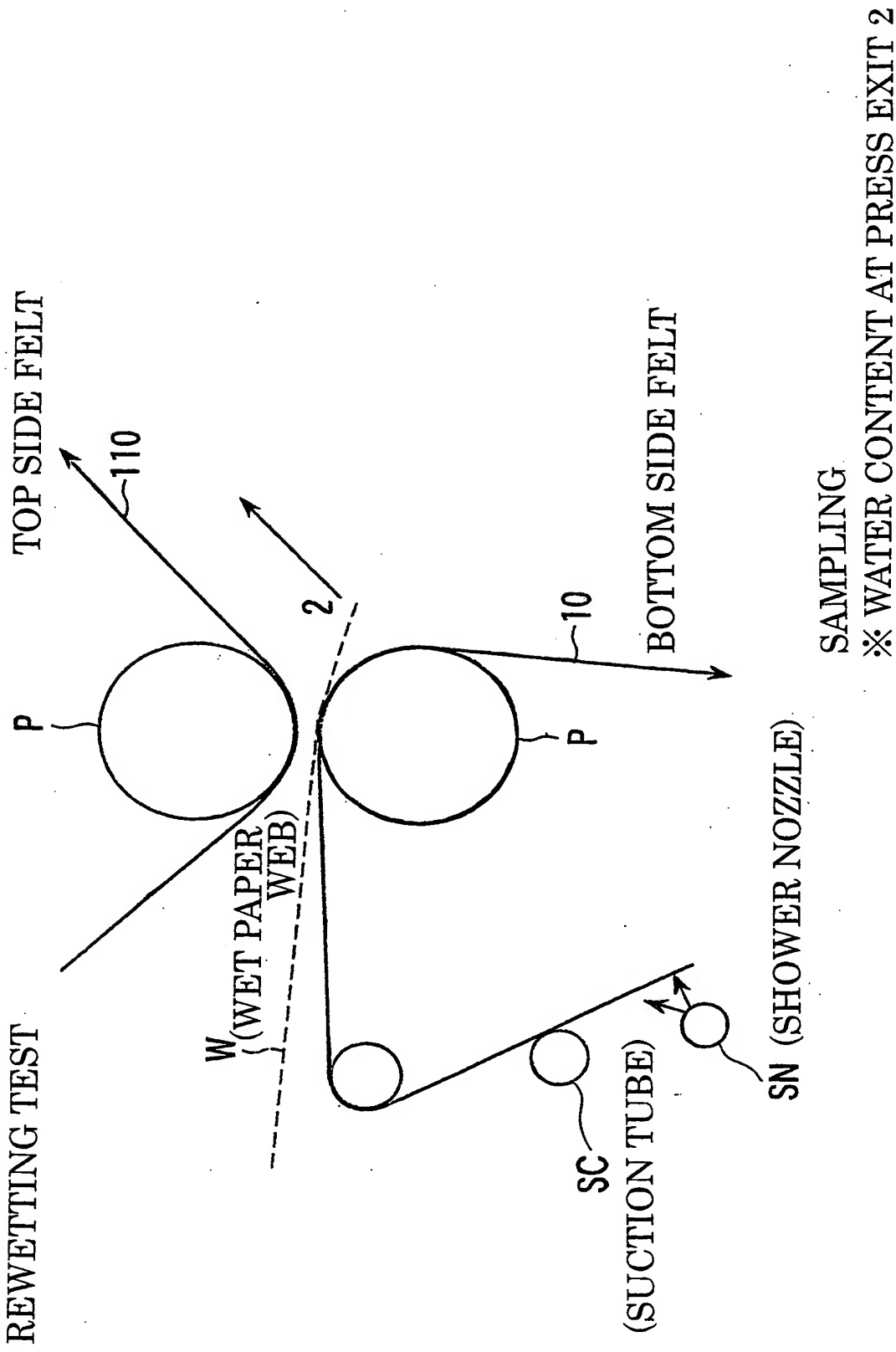

REWETTING TEST
TOP SIDE FELT
110
P
W
(WET PAPER WEB)
1
10
BOTTOM SIDE FELT
P
SC
(SUCTION TUBE)
SN (SHOWER NOZZLE)
SAMPLING
※ WATER CONTENT AT PRESS EXIT 1

FIG. 10


REWETTING TEST
TOP SIDE FELT
110
P
W
(WET PAPER WEB)
2
10
BOTTOM SIDE FELT
P
SC
(SUCTION TUBE)
SN (SHOWER NOZZLE)
SAMPLING
※ WATER CONTENT AT PRESS EXIT 2

	STRUCTURE OF NONWOVEN FABRIC	BASIS WEIGHT OF NONWOVEN FABRIC	WATER CONTACT ANGLE ON NONWOVEN FABRIC	BATT LAYER 31A	WATER CONTENT AT PRESS EXIT 2(%)	WATER CONTENT AT PRESS EXIT 1(%)	REWETTING EVALUATION
EXAMPLE 1	NYLON 6 SPUNBOND	40g/m^2	20°	MATERIAL:NYLON 6 STAPLE FIBER FINENESS:6 dtex BASIS WEIGHT: 200g/m^2	48.0	48.2	○
EXAMPLE 2	DITTO	25g/m^2	DITTO	DITTO	48.0	48.7	△
EXAMPLE 3	DITTO	40g/m^2	DITTO	MATERIAL:NYLON 6 STAPLE FIBER FINENESS: 6 dtex BASIS WEIGHT: 120g/m^2	48.1	48.8	△
EXAMPLE 4	DITTO	20g/m^2	DITTO	MATERIAL:NYLON 6 STAPLE FIBER FINENESS: 6 dtex BASIS WEIGHT: 200g/m^2	47.5	50.1	×
EXAMPLE 5	DITTO	100g/m^2	DITTO	DITTO	47.7	50.2	×
EXAMPLE 6	DITTO	40g/m^2	DITTO	MATERIAL:NYLON 6 STAPLE FIBER FINENESS: 11 dtex BASIS WEIGHT: 200g/m^2	48.1	48.6	△
EXAMPLE 7	DITTO	DITTTO	DITTO	MATERIAL:NYLON 6 STAPLE FIBER FINENESS: 17 dtex BASIS WEIGHT: 200g/m^2	48.2	48.8	△
COMPARA-TIVE EXAMPLE 1	NONE	NONE	-	ALL BATT LAYERS MEET THE FOLLOWING CONDITIOONS: MATERIAL:NYLON 6 STAPLE FIBER FINENESS: 6 dtex BASIS WEIGHT: 100g/m^2	47.5	50.0	×
COMPARA-TIVE EXAMPLE 2	NONE	NONE	-	ALL BATT LAYERS MEET THE FOLLOWING CONDITIONS: MATERIAL:NYLON 6 STAPLE FIBER FINENESS: 17 dtex BASIS WEIGHT: 100g/m^2	47.8	50.2	×
COMPARA-TIVE EXAMPLE 3	POLYESTER SPUNBOND	40g/m^2	40°	MATERIAL:NYLON 6 STAPLE FIBER FINENESS: 6 dtex BASIS WEIGHT: 200g/m^2	48.0	50.0	×
COMPARA-TIVE EXAMPLE 4	NYLON 6 SPUNBOND (PROVIDED ON SURFACE OF BASE BODY 20 ON ROLL SIDE)	40g/m^2	20°	MATERIAL:NYLON 6 STAPLE FIBER FINENESS: 6 dtex BASIS WEIGHT: 200g/m^2	47.6	50.0	×

REWETTING EVALUATION:1-2→BELOW 0.5:○, 0.5 OR MORE AND BELOW 1.0:△, ABOVE 1.0:×

FIG. 11

FIG. 12

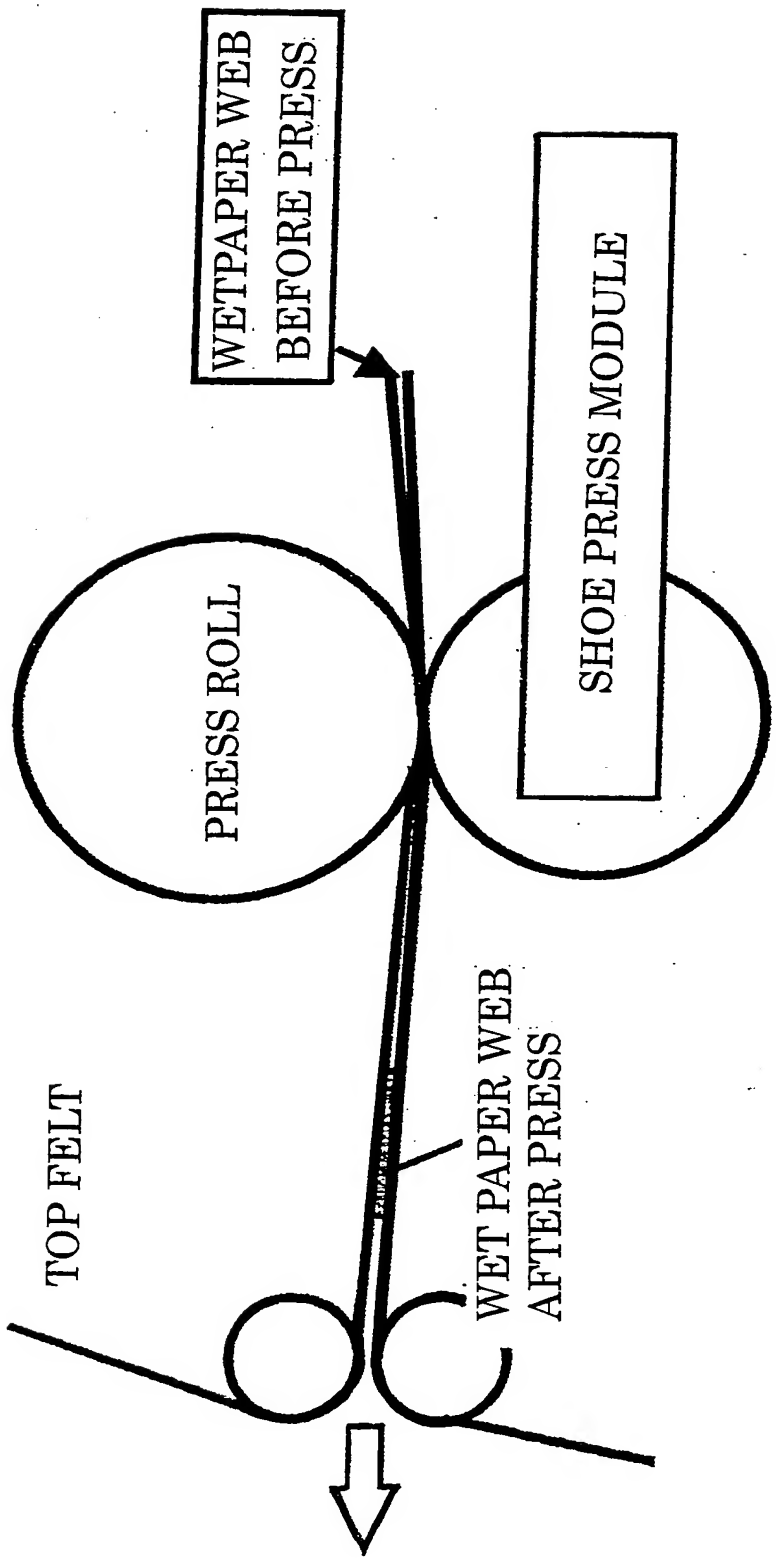

WETPAPER WEB
BEFORE PRESS
PRESS ROLL
SHOE PRESS MODULE
TOP FELT
WET PAPER WEB
AFTER PRESS

FIG. 13

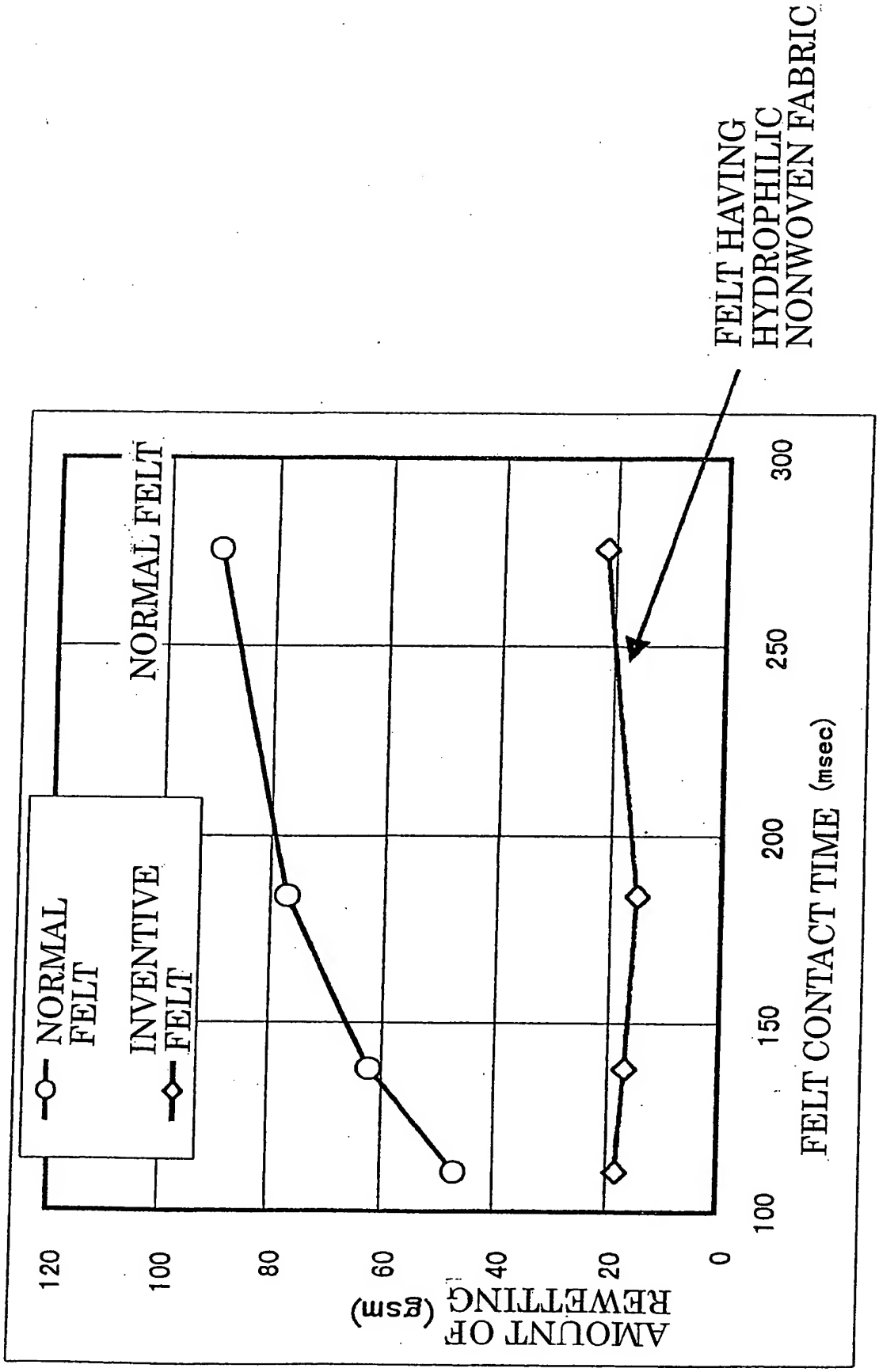

AMOUNT OF REWETTING (gsm)
120
100
80
60
40
20
0
100
150
200
250
300
FELT CONTACT TIME (msec)
NORMAL FELT
INVENTIVE FELT
NORMAL FELT
FELT HAVING HYDROPHILIC NONWOVEN FABRIC

FIG. 14